Outcomes Following Total Shoulder Arthroplasty in Geriatric Patients with Anorexia of Aging

Alexander R. Zhu [1], Eve R. Glenn [1], Eric Mao [1], Emma Giarracco [1], Henry Stewart [1], Seyedeh Zahra Mousavi [2], Ashley R. Zhu [3], Umasuthan Srikumaran [2] (*)

(*) Corresponding author: us@jhmi.edu
1. School of Medicine, The Johns Hopkins University, Baltimore, MD 21205, USA.
2. The Department of Orthopaedic Surgery, The Johns Hopkins University, Baltimore, MD 21205, USA.
3. Department of Biological Sciences, Northwestern University, Evanston, IL 60201, USA.

Background: Anorexia of aging (AoA), characterized by decreased appetite/food intake in elderly individuals, leads to malnutrition, sarcopenia, and frailty. While these factors are associated with increased postoperative complications in orthopaedic patients, the relationship between AoA and total shoulder arthroplasty (TSA) outcomes is unknown.

Purpose: To evaluate the association between AoA and postoperative outcomes following TSA in geriatric patients.

Methods: Using TriNetX platform data, this retrospective study compared outcomes between AoA patients ≥ 65 years undergoing TSA and non-AoA patients ≥ 65 years undergoing TSA. Propensity score matching controlled for demographic and comorbidity differences. Outcomes were assessed at 90 days, 1 year, and 2 years postoperatively and included acute kidney failure, myocardial infarction, deep vein thrombosis, pulmonary embolism, pneumonia, mechanical ventilation, dehiscence, sepsis, infection (superficial, deep, prosthetic), revision TSA, aseptic loosening, prosthesis dislocation, periprosthetic fracture, and mortality.

Results: From 64,788 patients, 1,044 matched pairs were analyzed. AoA patients showed higher revision TSA rates at 90 days (3.4% vs 1.6%, P = 0.0115), but not at 1 year (3.8% vs 2.6%, P = 0.1065) or 2 years (4.4% vs 3.1%, P = 0.1062). AoA was significantly associated with increased mortality at 90 days (1.0% vs 0%, P = 0.0015), but this association disappeared at 1 year (3.3% vs 2.6%, P = 0.3630) and 2 years (5.4% vs 4.6%, P = 0.4210). AoA was also associated with a higher incidence of deep vein thrombosis (DVT) and pneumonia at 90 days, 1 year, and 2 years (all P-values < 0.05).

Conclusions: AoA was associated with increased short-term revision surgery and mortality following TSA, as well as higher overall risk of DVT and pneumonia. These findings underscore the need for tailored preoperative and postoperative care strategies to improve outcomes in geriatric patients with AoA undergoing TSA.

What this study adds: This study is the first to demonstrate an association between anorexia of aging and increased short-term risks of revision surgery, mortality, deep vein thrombosis, and pneumonia following total shoulder arthroplasty in older adults.

Potential impacts on research, practice or policy: These findings emphasize the importance of preoperative screening for anorexia of aging.

Study Design: Retrospective Study-Defined

Level of Evidence: III

Keywords: Anorexia of aging; Malnutrition; Total shoulder arthroplasty; Geriatric surgery; Revision surgery; Postoperative complications

https://doi.org/10.70885/hmsj.2025.12.001

Introduction

Geriatric patients often fail to ingest an adequate amount of food to meet their essential nutrient requirements. This decrease in appetite and/or food intake during old age has been termed anorexia of aging (AoA). Among individuals who are at least 65 years old, 1.1% are estimated to have AoA [1]. It is a contributing factor to under-nutrition and adverse health outcomes in the geriatric population [2]. However, AoA is frequently overlooked by clinicians because it is often considered a natural part of aging [3].

AoA impacts many organ systems, including the musculoskeletal system. A strong association has been demonstrated between AoA and conditions that compromise musculoskeletal health, such as sarcopenia and frailty [4][5][6]. This is in part because AoA leads to inadequate nutrient intake, meaning that patients with AoA often experience protein-energy malnutrition and general nutrient and vitamin deficiency [2]. Protein-energy malnutrition is known to be

associated with decreased bone mass, delayed recovery from surgery, and impaired muscle function [7]. Vitamin deficiencies are also independently related to worsened bone health [8]. Beyond AoA, the link between other eating disorders and poor bone health has been well established in the orthopaedic literature. Anorexia nervosa in adult patients is known to be associated with decreased bone density, increased bone resorption, fracture risk, and osteoporosis [9] [10]. Similarly, patients with bulimia nervosa have been found to have lower bone mineral density compared to healthy controls [11]. Despite the known impact of eating disorders on bone health, there is limited research on how AoA specifically influences outcomes in joint replacement surgeries. Understanding the effects of AoA on shoulder arthroplasty outcomes in particular is especially important, especially in the elderly who are at higher risk of malnutrition.

Total shoulder arthroplasty (TSA) is used to treat conditions such as osteoarthritis and rotator cuff arthropathy [12]. The success of these procedures depends on many factors, including bone quality, muscle health, patient fitness, and nutritional status [13]. Given the concurrent rise in the mean age of the US population, the predicted increase in shoulder arthroplasty utilization rates over the next two decades, and the known relationship between malnutrition and bone health, further investigation is needed to provide a thorough understanding of the relationship between AoA and shoulder arthroplasty [14]. This study aims to elucidate the association between AoA and TSA outcomes in geriatric patients. The authors hypothesize that AoA is associated with increased rates of revision surgery, mortality, and postoperative complications following TSA.

Methods

Data Source

This retrospective cohort study was conducted using data obtained from the TriNetX platform, a global federated research network. TriNetX provides aggregated clinical data from over 130 million patients across various healthcare organizations, including data spanning up to 20 years before the date of analysis. Since this data was de-identified on the platform in accordance with Section §164.514(a) of the Health Insurance Portability and Accountability Act (HIPAA) Privacy Rule, the study did not require approval from the Institutional Review Board.

Patient Selection

In line with previous studies, all patients ≥ 65 years old who had a documented history of anorexia (ICD-10: R63.0) prior to undergoing total shoulder arthroplasty (TSA, CPT: 23742) were included [1][15][16]. Patients with a history of anorexia nervosa (ICD-10: F50.0) or malignant neoplasm (ICD-10: C80.1; ICD-O: 8000/3) were excluded from the analysis. The date of the TSA was the index event. Two cohorts were established: patients with a documented history of anorexia before TSA and those without a history of anorexia.

Propensity Score Matching

Baseline comparisons of demographics and comorbidities were made up to one day before the index event. Patients who had the index event more than 20 years ago were excluded from propensity score matching. Univariate analysis considered demographic variables (age, sex, ethnicity, race) and comorbidities, including diabetes mellitus (ICD-10: E08-E13), essential (primary) hypertension (ICD-10: I10-I1A), atrial fibrillation and flutter (ICD-10: I48), chronic ischemic heart disease (ICD-10: I25), heart failure (ICD-10: I50), chronic kidney disease (ICD-10: N18), chronic obstructive pulmonary disease (ICD-10: J44), use of vitamins (ICD-10: VT050, VT100, VT400, VT500, VT600, VT700, VT800, VT900), nicotine dependence (ICD-10: F17), and overweight or obese (ICD-10: E66).

Propensity score matching was conducted using 1:1 nearest neighbor greedy matching, which aims to balance all demographic variables and significant comorbidities from the univariate analysis. The standard mean difference was assessed to ensure a residual imbalance below 0.1, indicating successful matching. Data were reported as means, P-values, and standard differences.

Outcomes

Post-matching, outcomes were examined within the first 90 days, 1 year, and 2 years following TSA. Medical outcomes included acute kidney failure (AKF), myocardial infarction (MI), deep vein thrombosis (DVT), pulmonary embolism (PE), pneumonia, mechanical ventilation, dehiscence, and sepsis. Orthopaedic outcomes examined between the cohorts included infection (superficial, deep, prosthetic), revision TSA, aseptic loosening, prosthesis dislocation, periprosthetic fracture, and mortality. Specific billing codes used for outcomes are detailed in **Supplemental Table 1.** Due to patient privacy protocols, TriNetX does not release any outcomes with less than 10 patients and instead reports such event frequencies as "≤10".

Statistical Analyses

Statistical analyses were performed using the TriNetX platform. Differences in demographics, comorbidities, and outcomes were analyzed using Student's t-tests for continuous variables and chi-square tests for categorical variables. To assess measures of association, risk ratios and their corresponding 95% confidence intervals were calculated. Statistical significance was set at $P < 0.05$.

Results

Study Population

The study included a total of 64,788 geriatric patients ≥ 65 years old who underwent TSA. Of these, 1,045 (1.6%) patients were identified as having AoA (Anorexia cohort), while the remaining 63,743 (98.4%) patients formed the No Anorexia cohort. Baseline demographic variables and comorbidities for these patients before and after propensity score matching are detailed in **Table 1**.

Demographics and Comorbidities Between Cohorts

Prior to propensity score matching, the mean age at the time of TSA was 74.0 ± 7.2 years in the Anorexia cohort and 71.6 ± 7.0 years in the No Anorexia cohort ($P < 0.0001$, **Table 1**). Gender distribution also differed significantly between the Anorexia and No Anorexia cohorts (Female, $P < 0.0001$; Male, $P < 0.0001$). Patients with AoA were more likely to be non-Hispanic or Latino ($P = 0.0005$), Black or African-American ($P < 0.0001$), White ($P < 0.0001$), American Indian or Alaska Native ($P < 0.0001$), or Native Hawaiian or Other Pacific Islander ($P < 0.0001$). The Anorexia cohort were also more likely to have any of the examined comorbidities compared to the No Anorexia cohort (all P-values < 0.05).

Table 1: Baseline demographics and comorbidities of total shoulder arthroplasty patients with and without anorexia of aging.

Before Matching (n = 64,788)						
	Anorexia Cohort	*Percent or Mean ± SD*	*No Anorexia Cohort*	*Percent or Mean ± SD*	*P-Value*	*Standard Difference*
Age at Index	1,045	74.0 ± 7.2	63,743	71.6 ± 7.0	**< 0.0001**	0.3
Male	329	31.5%	26,556	41.7%	**< 0.0001**	0.2
Female	687	65.7%	35,100	55.1%	**< 0.0001**	0.2
Black or African American	105	10.0%	3,408	5.3%	**< 0.0001**	0.2
White	845	80.9%	54,249	85.1%	**0.0001**	0.1
Asian	12	1.1%	654	1.0%	0.6974	0.0
American Indian or Alaska Native	10	1.0%	180	0.3%	**< 0.0001**	0.1
Native Hawaiian or Other Pacific Islander	10	1.0%	91	0.1%	**< 0.0001**	0.1
Other Race	20	1.9%	1,012	1.6%	0.4034	0.0
Hispanic or Latino	40	3.8%	2,229	3.5%	0.5638	0.0
Not Hispanic or Latino	863	82.6%	49,778	78.1%	**0.0005**	0.1
Diabetes mellitus	412	39.4%	14,960	23.5%	**< 0.0001**	0.3
Atrial fibrillation and flutter	222	21.2%	7,291	11.4%	**< 0.0001**	0.3
Essential (primary) hypertension	914	87.5%	41,078	64.4%	**< 0.0001**	0.6
Chronic kidney disease (CKD)	385	36.8%	8,233	12.9%	**< 0.0001**	0.6
Other chronic obstructive pulmonary disease	280	26.8%	6,687	10.5%	**< 0.0001**	0.3
Heart failure	288	27.6%	6,097	9.6%	**< 0.0001**	0.5
Chronic ischemic heart disease	467	44.7%	13,786	21.6%	**< 0.0001**	0.5
Vitamin D	585	56.0%	18,376	28.8%	**< 0.0001**	0.6
Vitamin B	497	47.6%	13,953	21.9%	**< 0.0001**	0.6
Vitamin C	289	27.7%	8,213	12.9%	**< 0.0001**	0.4
Vitamins, Combination	234	22.4%	5,353	8.4%	**< 0.0001**	0.4

Vitamin E	145		3,961	6.2%	**< 0.0001**	0.3
Vitamin K	91	8.7%	1,365	2.1%	**< 0.0001**	0.3
Vitamin A	70	6.7%	1,704	2.7%	**< 0.0001**	0.2
Vitamins, Other	24	2.3%	604	0.9%	**< 0.0001**	0.1
Nicotine dependence	242	23.2%	6,687	10.5%	**< 0.0001**	0.3
Overweight or obese	495	47.4%	19,197	30.1%	**< 0.0001**	0.4
After Matching (n = 2,088)						
	Anorexia Cohort	*Percent or Mean ± SD*	*No Anorexia Cohort*	*Percent or Mean ± SD*	*P-Value*	*Standard Difference*
Age at Index	1,044	74.0 ± 7.2	1,044	73.9 ± 7.0	0.8345	0.0
Male	329	31.5%	342	32.8%	0.5424	0.0
Female	686	65.7%	680	65.1%	0.7825	0.0
Black or African American	105	10.0%	93	8.9%	0.3701	0.0
White	844	80.8%	856	82.0%	0.4996	0.0
Asian	12	1.1%	18	1.7%	0.2699	0.0
American Indian or Alaska Native	10	1.0%	10	1.0%	1.0000	0.0
Native Hawaiian or Other Pacific Islander	10	1.0%	10	1.0%	1.0000	0.0
Other Race	20	1.9%	14	1.3%	0.2995	0.0
Hispanic or Latino	40	3.8%	34	3.3%	0.4776	0.0
Not Hispanic or Latino	862	82.6%	870	83.3%	0.6415	0.0
Diabetes mellitus	411	39.4%	410	39.3%	0.9643	0.0
Atrial fibrillation and flutter	221	21.2%	214	20.5%	0.7060	0.0
Essential (primary) hypertension	913	87.5%	941	90.1%	0.0521	0.0
Chronic kidney disease (CKD)	384	36.8%	366	35.1%	0.4116	0.0
Other chronic obstructive pulmonary disease	279	26.7%	267	25.6%	0.5501	0.0
Heart failure	287	27.5%	285	27.3%	0.9218	0.0
Chronic ischemic heart disease	466	44.6%	466	44.6%	1.0000	0.0

Vitamin D	584	55.9%	612	58.6%	0.2154	0.0
Vitamin B	496	47.5%	516	49.4%	0.3811	0.0
Vitamin C	289	27.7%	279	26.7%	0.6229	0.0
Vitamins, Combination	234	22.4%	224	21.5%	0.5969	0.0
Vitamin E	145	13.9%	141	13.5%	0.7990	0.0
Vitamin K	90	8.6%	78	7.5%	0.3343	0.0
Vitamin A	70	6.7%	64	6.1%	0.5921	0.0
Vitamins, Other	24	2.3%	18	1.7%	0.3496	0.0
Nicotine dependence	241	23.1%	250	23.9%	0.6423	0.0
Overweight or obese	490	46.9%	479	45.9%	0.6293	0.0

Note: 1:1 propensity matching by age at index event, gender, race, ethnicity, diabetes mellitus, essential (primary) hypertension, atrial fibrillation and flutter, chronic ischemic heart disease, heart failure, chronic kidney disease, chronic obstructive pulmonary disease, use of vitamins, nicotine dependence, and overweight or obese.

Matching demographics and comorbidities included age at index event, gender, race, ethnicity, diabetes mellitus, essential (primary) hypertension, atrial fibrillation and flutter, chronic ischemic heart disease, heart failure, chronic kidney disease, chronic obstructive pulmonary disease, use of vitamins, nicotine dependence, and overweight or obese. Post-matching, both the Anorexia and No Anorexia cohorts consisted of 1,044 patients each. Demographic and comorbidity differences between cohorts were no longer significant, with matching balance confirmed by standardized differences (all P-values > 0.05).

Clinical Outcomes at 90 Days, 1 Year, and 2 Years in Anorexia and No Anorexia Cohorts

The clinical outcomes for the Anorexia and No Anorexia groups at 90 days, 1 year, and 2 years post-index event (i.e. post-TSA) are shown in **Table 2**. After propensity score matching, AoA prior to TSA was significantly associated with a higher incidence of revision TSA (3.4% vs 1.6%, P = 0.0115) and mortality (1.0% vs 0%, P = 0.0015) at 90 days. AoA was also associated with a higher incidence of DVT (2.0% vs 1.0%, P = 0.0465) and pneumonia (4.4% vs 2.7%, P = 0.0331) at 90 days. At 1 year post-TSA, AoA remained significantly associated with higher rates of DVT (3.7% vs 1.4%, P = 0.0009) and pneumonia (9.0% vs 6.4%, P = 0.0268). However, there was no association between AoA and 1-year revision TSA (3.8% vs 2.6%, P = 0.1065) or mortality (3.3% vs 2.6%, P = 0.3630). At 2 years follow-up, AoA remained associated with increased rates of DVT (4.3% vs 2.1%, P = 0.0043) and pneumonia (13.4% vs 9.6%, P = 0.0061).

Discussion

This study aimed to assess the impact of AoA on clinical outcomes following TSA. The present study found that 1.6% of TSA patients who are at least 65 years old have a diagnosis of AoA, which aligns with the annual prevalence of 1.1% calculated by Dagenais et al. [1]. Additionally, this study demonstrated that AoA prior to TSA is significantly associated with higher rates of revision TSA and mortality in the 90-day period, but not at 1-year or 2 years follow-up. AoA is also associated with increased risk for DVT and pneumonia at the 90-day, 1-year, and 2-year points.

The association between AoA prior to TSA and increased rates of revision surgeries and mortality within the first 90 days postoperatively may be attributed to several interrelated factors. Physiologically, AoA often leads to malnutrition, which can significantly impair postoperative recovery. Malnutrition is associated with a higher risk of complications such as infections, delayed wound healing, and overall poorer surgical outcomes following TSA [17]. The loss of appetite seen in older patients with AoA can lead to reduced muscle mass and strength, which are critical for recovery after TSA [18]. This decline in physical condition can lead to increased rates of postoperative complications, potentially leading to revision surgeries and even death. Moreover, malnutrition and decreased muscle mass may impair the patient's ability to participate in postoperative physical therapy, further compromising joint function and integration of the prosthesis. Psychological factors also may play a significant role in the postoperative trajectory of elderly patients with AoA. Older adults often experience a range of psychological challenges, including depression and anxiety, which can be exacerbated by the experience of surgery and the associated recovery process [19]. These psychological issues may hinder adherence to postoperative rehabilitation protocols, further complicating recovery and increasing the likelihood of complications that may require revision surgery. The interplay between malnutrition and psychological distress can create a vicious cycle, where poor nutritional status leads to worse psychological outcomes, which in turn exacerbates physical health issues [20]. Another contributing factor to the poorer outcomes in AoA patients may be the reduced bone density and compromised musculoskeletal health often observed in this population. Previous research has shown that AoA can accelerate the development of sarcopenia and osteoporosis, conditions that compromise the structural integrity of bones and muscles [4][5]. In the context of TSA, weakened bones can lead to implant loosening, increasing the likelihood of revision surgeries.

Table 2: Outcomes at 90 days, 1 year, and 2 years following propensity score matching between cohorts with and without anorexia of aging who received a total shoulder arthroplasty.

90 Day Outcomes						
	Anorexia (n=1,044)		*No Anorexia (n=1,044)*		*P-Value*	*Risk Ratio (95% CI)*
Acute kidney failure (AKF)	65	6.3%	59	5.7%	0.5785	1.1 (0.8, 1.6)
Myocardial infarction (MI)	14	1.3%	16	1.5%	0.7130	0.9 (0.4, 1.8)
Deep vein thrombosis (DVT)	21	2.0%	≤10	1.0%	**0.0465**	2.1 (1.0, 4.4)
Pulmonary embolism (PE)	23	2.2%	20	1.9%	0.6439	1.2 (0.6, 2.1)
Pneumonia	46	4.4%	28	2.7%	**0.0331**	1.6 (1.0, 2.6)
Mechanical ventilation	17	1.6%	16	1.5%	0.8607	1.1 (0.5, 2.1)
Dehiscence	≤10	1.0%	≤10	1.0%	1.0000	1.0 (0.4, 2.4)
Sepsis	15	1.4%	17	1.6%	0.7216	0.9 (0.4, 1.8)
Superficial surgical site infection (superficial SSI)	≤10	1.0%	≤10	1.0%	1.0000	1.0 (0.4, 2.4)
Deep surgical site infection (deep SSI)	≤10	1.0%	≤10	1.0%	1.0000	1.0 (0.4, 2.4)
Prosthetic joint infection (PJI)	15	1.4%	19	1.8%	0.4892	0.8 (0.4, 1.5)
Revision total shoulder arthroplasty	35	3.4%	17	1.6%	**0.0115**	2.1 (1.2, 3.7)
Aseptic loosening	≤10	1.0%	≤10	1.0%	1.0000	1.0 (0.4, 2.4)
Prosthesis dislocation	27	2.6%	17	1.6%	0.1276	1.6 (0.9, 2.9)
Periprosthetic fracture	≤10	1.0%	≤10	1.0%	1.0000	1.0 (0.4, 2.4)
Mortality	≤10	1.0%	0	0.0%	**0.0015**	1.0 (0.4, 2.4)
1 Year Outcomes						
	Anorexia (n=1,044)		*No Anorexia (n=1,044)*		*P-Value*	*Risk Ratio (95% CI)*
Acute kidney failure (AKF)	129	12.4%	117	11.2%	0.4153	1.1 (0.9, 1.4)
Myocardial infarction (MI)	35	3.4%	36	3.4%	0.9039	1.0 (0.6, 1.5)
Deep vein thrombosis (DVT)	39	3.7%	15	1.4%	**0.0009**	2.6 (1.4, 4.7)

Pulmonary embolism (PE)	35	3.4%	30	2.9%	0.5287	1.2 (0.7, 1.9)
Pneumonia	94	9.0%	67	6.4%	**0.0268**	1.4 (1.0, 1.9)
Mechanical ventilation	33	3.2%	31	3.0%	0.7996	1.1 (0.7, 1.7)
Dehiscence	≤10	1.0%	≤10	1.0%	1.0000	1.0 (0.4, 2.4)
Sepsis	43	4.2%	43	4.2%	1.0000	1.0 (0.7, 1.5)
Superficial surgical site infection (superficial SSI)	≤10	1.0%	≤10	1.0%	1.0000	1.0 (0.4, 2.4)
Deep surgical site infection (deep SSI)	≤10	1.0%	≤10	1.0%	1.0000	1.0 (0.4, 2.4)
Prosthetic joint infection (PJI)	19	1.8%	22	2.1%	0.6361	0.9 (0.5, 1.6)
Revision total shoulder arthroplasty	40	3.8%	27	2.6%	0.1065	1.5 (0.9, 2.4)
Aseptic loosening	≤10	1.0%	14	1.3%	0.4115	0.7 (0.3, 1.6)
Prosthesis dislocation	33	3.2%	22	2.1%	0.1328	1.5 (0.9, 2.6)
Periprosthetic fracture	11	1.1%	15	1.4%	0.4299	0.7 (0.3, 1.6)
Mortality	34	3.3%	27	2.6%	0.3630	1.3 (0.8, 2.1)
2 Year Outcomes						
	Anorexia (n=1,044)		*No Anorexia (n=1,044)*		*P-Value*	*Risk Ratio (95% CI)*
Acute kidney failure (AKF)	174	16.7%	162	15.5%	0.6377	1.0 (0.9, 1.3)
Myocardial infarction (MI)	56	5.4%	53	5.1%	0.7679	1.1 (0.7, 1.5)
Deep vein thrombosis (DVT)	45	4.3%	22	2.1%	**0.0043**	2.0 (1.2, 3.4)
Pulmonary embolism (PE)	43	4.1%	37	3.5%	0.4939	1.2 (0.8, 1.8)
Pneumonia	140	13.4%	100	9.6%	**0.0061**	1.4 (1.1, 1.8)
Mechanical ventilation	47	4.5%	41	3.9%	0.5134	1.1 (0.8, 1.7)
Dehiscence	13	1.2%	15	1.4%	0.7036	0.9 (0.4, 1.8)
Sepsis	75	7.2%	68	6.5%	0.5442	1.1 (0.8, 1.5)
Superficial surgical site infection (superficial SSI)	≤10	1.0%	≤10	1.0%	1.0000	1.0 (0.4, 2.4)

Deep surgical site infection (deep SSI)	≤10	1.0%	≤10	1.0%	1.0000	1.0 (0.4, 2.4)
Prosthetic joint infection (PJI)	25	2.4%	26	2.5%	0.8873	1.0 (0.6, 1.7)
Revision total shoulder arthroplasty	46	4.4%	32	3.1%	0.1062	1.4 (0.9, 2.2)
Aseptic loosening	≤10	1.0%	18	1.7%	0.1280	0.6 (0.3, 1.2)
Prosthesis dislocation	37	3.5%	24	2.3%	0.0912	1.5 (0.9, 2.6)
Periprosthetic fracture	15	1.4%	18	1.7%	0.5986	0.8 (0.4, 1.6)
Mortality	56	5.4%	48	4.6%	0.4210	1.2 (0.8, 1.7)

Note: 1:1 propensity matching by age at index event, gender, race, ethnicity, diabetes mellitus, essential (primary) hypertension, atrial fibrillation and flutter, chronic ischemic heart disease, heart failure, chronic kidney disease, chronic obstructive pulmonary disease, use of vitamins, nicotine dependence, and overweight or obese.

Another key finding was that AoA is associated with increased risk of DVT and pneumonia in the short- and long-term postoperative period. In the literature, there is no direct evidence that patients with AoA experience increased rates of DVT or pneumonia as a direct consequence of AoA itself. However, AoA is strongly associated with malnutrition, sarcopenia, and functional decline, all of which are established risk factors for both DVT and pneumonia in older adults [2][21][22][23]. Functional impairment, reduced mobility, and sedentary lifestyle, all of which are common sequelae of AoA, are independently associated with a significantly increased risk of venous thrombosis in older adults [24][25]. Specifically, impaired mobility and sedentary behavior confer odds ratios of 2.9–4.0 for venous thrombosis in this population [24]. Similarly, malnutrition and sarcopenia increase susceptibility to infections, including pneumonia, due to impaired immune function and reduced respiratory muscle strength [22][2].

This study has multiple strengths. TriNetX yielded a large cohort of 64,788 patients with and without AoA who underwent TSA. Through propensity score matching, the authors controlled for demographics and comorbidities related to AoA, which reduced the impact of any confounding variables on this study's findings. Nevertheless, there are several limitations. First, the DSM-5 does not specify AoA. Therefore, this study defined AoA using the ICD-10 billing code for anorexia (R63.0) in patients of at least 65 years of age, which are in line with previous literature [1][15][16]. Another limitation is that TriNetX does not capture important factors such as patients' nutritional status, dietary intake, or specific postoperative rehabilitation protocols, which could have influenced the study outcomes. Furthermore, TriNetX does not allow the analysis to restrict inclusion to patients diagnosed with anorexia specifically at age 65 or older. Therefore, individuals with a documented history of anorexia in their youth may also be included, although the ICD-10 code R63.0 for anorexia is more commonly assigned to older patients.

This study demonstrates that patients with a history of AoA are at an increased short-term risk of revision TSA and mortality following TSA, and overall risk of DVT and pneumonia. These findings highlight the need for tailored preoperative assessments and postoperative care strategies for these patients. Further research is necessary to explore the mechanisms underlying these outcomes and to develop interventions aimed at improving recovery in this patient population.

Conclusion

In conclusion, the present study demonstrated that patients with AoA are more likely to undergo revision TSA or experience death in the short-term postoperative period following TSA. Additionally, those with AoA are more likely to experience DVT or pneumonia postoperatively.

Orthopaedic surgeons should be aware of this condition and provide patients with the proper resources to mitigate this risk. Addressing AoA through targeted interventions, such as nutritional support and mental health care, is essential to improve outcomes for this vulnerable population.

Open access statement

This is an open-access article distributed under the terms of the Creative Commons Attribution Licence for Commercial and Non-Commercial Purposes (**CC BY 4.0**, see **https://creativecommons.org/licenses/by/4.0/**), which allows free use, distribution, adaptation, and commercial use of a work, provided proper credit is given to the creator.

Funding Statement

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Conflict of Interest Statement

Outside of this work, Dr. Srikumaran serves as a board or committee member for AAOS, American Shoulder and Elbow Surgeons, and IASES; reports stock or stock options from ROM3, Sonogen, and Tigon Medical; is a paid consultant for, and receives intellectual property royalties from, Fx Shoulder

and Tigon Medical; receives other financial or material support from Arthrex, Depuy – a Johnson & Johnson Company, and Thieme; and has been a paid presenter or speaker for, and received research support from, Fx Shoulder. The remaining authors have no disclosures to report.

Ethical Approval

This study used fully de-identified data from the TriNetX platform, in accordance with HIPAA Privacy Rule Section §164.514(a), and therefore did not require formal Institutional Review Board approval.

References

1. Dagenais S, Fielding RA, Clark S, Cantu C, Prasad S, Groarke JD. Anorexia in Medicare Fee-for-Service Beneficiaries: A Claims-Based Analysis of Epidemiology and Mortality. J Nutr Health Aging. 2023;27(3):184–91.
2. Landi F, Calvani R, Tosato M, Martone A, Ortolani E, Savera G, et al. Anorexia of Aging: Risk Factors, Consequences, and Potential Treatments. Nutrients. 2016 Jan 27;8(2):69.
3. Jadczak AD, Visvanathan R. Anorexia of Aging - An Updated Short Review. J Nutr Health Aging. 2019;23(3):306–9.
4. Fried LP, Tangen CM, Walston J, Newman AB, Hirsch C, Gottdiener J, et al. Frailty in Older Adults: Evidence for a Phenotype. The Journals of Gerontology Series A: Biological Sciences and Medical Sciences. 2001 Mar 1;56(3):M146–57.
5. Landi F, Liperoti R, Russo A, Giovannini S, Tosato M, Barillaro C, et al. Association of anorexia with sarcopenia in a community-dwelling elderly population: results from the ilSIRENTE study. Eur J Nutr. 2013 Apr;52(3):1261–8.
6. Calvani R, Martone AM, Marzetti E, Onder G, Savera G, Lorenzi M, et al. Pre-Hospital Dietary Intake Correlates with Muscle Mass at the Time of Fracture in Older Hip-Fractured Patients. Front Aging Neurosci [Internet]. 2014 Nov 19 [cited 2024 Oct 14];6. Available from: http://journal.frontiersin.org/article/10.3389/fnagi.2014.00
7. MacIntosh C, Morley JE, Chapman IM. The anorexia of aging. Nutrition. 2000 Oct;16(10):983–95.
8. Ahmadieh H, Arabi A. Vitamins and bone health: beyond calcium and vitamin D: Nutrition Reviews©, Vol. ••, No. ••. Nutrition Reviews. 2011 Oct;69(10):584–98.
9. Zuckerman-Levin N, Hochberg Z, Latzer Y. Bone health in eating disorders. Obes Rev. 2014 Mar;15(3):215–23.
10. Solmi M, Veronese N, Correll CU, Favaro A, Santonastaso P, Caregaro L, et al. Bone mineral density, osteoporosis, and fractures among people with eating disorders: a systematic review and meta-analysis. Acta Psychiatr Scand. 2016 May;133(5):341–51.
11. Robinson L, Aldridge V, Clark EM, Misra M, Micali N. A systematic review and meta-analysis of the association between eating disorders and bone density. Osteoporos Int. 2016 June;27(6):1953–66.
12. Buck FM, Jost B, Hodler J. Shoulder arthroplasty. Eur Radiol. 2008 Dec;18(12):2937–48.
13. Casp AJ, Montgomery SR, Cancienne JM, Brockmeier SF, Werner BC. Osteoporosis and Implant-Related Complications After Anatomic and Reverse Total Shoulder Arthroplasty. J Am Acad Orthop Surg. 2020 Feb 1;28(3):121–7.
14. Klug A, Herrmann E, Fischer S, Hoffmann R, Gramlich Y. Projections of Primary and Revision Shoulder Arthroplasty until 2040: Facing a Massive Rise in Fracture-Related Procedures. JCM. 2021 Oct 31;10(21):5123.
15. Cox NJ, Ibrahim K, Sayer AA, Robinson SM, Roberts HC. Assessment and Treatment of the Anorexia of Aging: A Systematic Review. Nutrients. 2019 Jan 11;11(1):144.
16. Fielding RA, Landi F, Smoyer KE, Tarasenko L, Groarke J. Association of anorexia/appetite loss with malnutrition and mortality in older populations: A systematic literature review. J cachexia sarcopenia muscle. 2023 Apr;14(2):706–29.
17. Liu SH, Cerri-Droz P, Loyst RA, Lung B, Kashanchi K, Komatsu DE, et al. The geriatric nutritional risk index as a strong predictor of adverse outcomes following total shoulder arthroplasty. JSES Int. 2024 Jan;8(1):152–8.
18. Sanford AM. Anorexia of aging and its role for frailty. Curr Opin Clin Nutr Metab Care. 2017 Jan;20(1):54–60.
19. Zhu J, Xu L, Sun L, Li J, Qin W, Ding G, et al. Chronic Disease, Disability, Psychological Distress and Suicide Ideation among Rural Elderly: Results from a Population Survey in Shandong. IJERPH. 2018 July 28;15(8):1604.
20. Ma L, Poulin P, Feldstain A, Chasen MR. The Association between Malnutrition and Psychological Distress in Patients with Advanced Head-and-Neck Cancer. Current Oncology. 2013 Dec 1;20(6):554–60.
21. Cox N. Consequences of Anorexia of Aging in Hospital Settings: An Updated Review. CIA. 2024 Mar;Volume 19:451–7.
22. Landi F, Picca A, Calvani R, Marzetti E. Anorexia of Aging. Clinics in Geriatric Medicine. 2017 Aug;33(3):315–23.
23. Rudzińska A, Piotrowicz K, Perera I, Gryglewska B, Gąsowski J. Poor Appetite in Frail Older Persons—A Systematic Review. Nutrients. 2023 June 29;15(13):2966.
24. Engbers MJ, Blom JW, Cushman M, Rosendaal FR, Van Hylckama Vlieg A. Functional Impairment and Risk of Venous Thrombosis in Older Adults. J American Geriatrics Society. 2017 Sept;65(9):2003–8.
25. Weill-Engerer S, Meaume S, Lahlou A, Piette F, Saint-Jean O, Sachet A, et al. Risk Factors for Deep Vein Thrombosis in Inpatients Aged 65 and Older: A Case-Control Multicenter Study. J American Geriatrics Society. 2004 Aug;52(8):1299–304.